

**APPLICATION FOR UNITED STATES
LETTERS PATENT**

**FOLDING ROLL FOR A FOLDING APPARATUS
AND METHODS FOR ITS PRODUCTION**

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BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The invention relates to a folding roll for a folding apparatus, which bears a frictional layer applied by means of thermal spray coating, and methods for producing the folding roll.

2. Description of the Related Art

[0002] Folding rolls are known in which carrying portions have been produced on the circumferential surface by means of material-removing methods and a ceramic layer has subsequently been applied by means of thermal spray coating.

[0003] The production of such folding rolls is time-consuming and expensive. In addition, only coarse fabrication tolerances can be achieved. Furthermore, irregularities occur on the profile of the frictional layer and, on the edges of the profile, the formation of burrs is to be noted, which can cause damage to the folded product.

SUMMARY OF THE INVENTION

[0004] It is an object of the invention to provide a folding roll which is distinguished by good shape and dimensional accuracy. In addition, a method for the inexpensive production of a folding roll is to be provided.

[0005] According to the invention, the object of providing a folding roll is achieved by applying a frictional material only to frictional areas on the even surface of the folding roll, thereby forming a frictional layer which is interrupted by deeper areas where the material has not been applied. The folding roll can be produced with little expenditure on time and costs. In addition, close fabrication tolerances can be maintained. The profile produced is also very uniform and can be produced without burrs which damage the folded product.

[0006] According to a preferred method, a sheet-metal mask having cut-outs with the shape of the desired frictional areas is fitted to the folding roll, the frictional layer is applied to the folding roll through the cut-outs by means of thermal spray coating, and the mask is removed. According to another method, a mask is wound spirally onto the circumferential surface of the folding roll, the frictional layer is applied to the areas not covered by the mask by means of thermal spray coating, and the mask is removed. By using a mask, the provision of carrying portions of the surface by means of specific production methods is rendered superfluous. The mask can be applied to the roll and removed from the latter with little expenditure on time and can be used many times. In addition, the frictional layer profiles can be produced more uniformly and without forming burrs, which improves the function of the folding roll. Moreover, the folding rolls

produced in accordance with the invention are distinguished by longer service lives and can be conditioned again by grinding off and re-coating, which is likewise reflected in lower costs. Further features and advantages emerge from the subclaims in conjunction with the description.

[0007] Other objects and features of the present invention will become apparent from the following detailed description considered in conjunction with the accompanying drawings. It is to be understood, however, that the drawings are designed solely for purposes of illustration and not as a definition of the limits of the invention, for which reference should be made to the appended claims. It should be further understood that the drawings are not necessarily drawn to scale and that, unless otherwise indicated, they are merely intended to conceptually illustrate the structures and procedures described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

- [0008] Fig. 1 shows a folding roll;
- [0009] Fig. 1A shows the associated mask used to apply the frictional layer;
- [0010] Fig. 2 shows the detail II according to Figure 1;
- [0011] Fig. 3 shows a further variant of a folding roll;
- [0012] Fig. 4 shows folding rolls in a third longitudinal folding apparatus; and
- [0013] Fig. 5 shows folding rolls on a folding former.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

[0014] Fig. 1 shows a folding roll 1 with circumferential surfaces F1 to F5, which are provided with a frictional layer 2. The frictional layer has the surface structure shown in Fig. 2. It comprises four-cornered frictional areas 3 which are bounded by deeper areas 4. In the exemplary embodiment, the four-cornered frictional areas 3 have a shape like a rhombus with about 8 and 16 mm spacing from the opposite corners. The deeper areas 4 are designed in the manner of parallel grooves with a width of, for example, 2 mm. The frictional area 3 can also have another surface structure, for example the form of triangles or rectangles.

[0015] The frictional layer 2 is applied by thermal spray-coating. For this purpose, first of all the mask 5 illustrated in Fig. 1A is fitted to the folding roll 1, that is to say wound on. The mask 5 has a width B dimensioned such that its ends 6, 7 meet each other and form a butt joint. The mask 5 wound on in this way is fixed by means of clips, not illustrated. Other fixings are also possible, for example by means of easily detachable spotting-on (spot welding).

[0016] The mask 5 has a thickness of 1 mm, for example, and has cutouts 8, of which the dimensions and the arrangement in relation to one another equate to the shape and the arrangement of the frictional areas 3. The cutouts 8 and the cutouts 9 also mentioned further below are advantageously cut with a laser beam. The mask 5 is fitted to the folding roll 1 and aligned axially in such a way that the cutouts 8 come to lie on the circumferential areas F1 to F5 to be provided with the frictional areas 3. The mask is shown in this axial alignment with the folding roll 1. The circumferential

surfaces F1 to F5 to be coated have an even surface. "Even" is understood to mean that these surfaces have been produced completely by normal surface treatment, for example by turning or grinding, and that special carrying portions have not been produced, for example by milling or chasing.

[0017] The frictional layer 2 is then applied to the folding roll 1 prepared in this way, first of all the roll surface advantageously being sand-blasted at the points intended for the layer application, which can therefore advantageously be carried out with the mask 5 clamped on. Next, an adhesive base is applied and then the frictional layer 2 is applied by means of thermal spray-coating, beneficially by means of flame-spraying. Carbide, self-flowing alloys and mixtures are advantageously applied. For example, use can be made of the spray powder offered by one manufacturer under the company designation Metco 34F. The layer is not intended to be remelted, in order that the tips of the granular spray powder are not rounded by melting, and the frictional layer has a high coefficient of friction. In the case of folding rolls, a high coefficient of friction is aimed at for the working surface, the frictional layer here, in order that the product to be folded can be drawn reliably into the inlet gap. The spray powder advantageously contains tungsten carbide. A metal layer is advantageously applied as the frictional layer 2 by means of the thermal spray-coating. However, an oxide-ceramic or metal-ceramic layer can also be applied. Further principles of thermal spray-coating are familiar to those skilled in the art, exemplified by U.S. Patent No. 5,644,828. The frictional layer 2 is applied, for example, with approximately a thickness $t = 0.3 \text{ mm}$ and, for example, has a maximum roughness $R_{\text{max}} \leq 0.2 \text{ mm}$.

[0018] The mask 5 also has rectangular cutouts 9 which come to lie above grooves 10 in the folding roll 1, in which tape lines 11 (see Fig. 4) run during folding operation. During the flame-spraying, rectangular frictional areas 12 shaped in accordance with the cutouts 9 are produced on the circumferential surfaces of the grooves 10. For reasons of simplicity, only one rectangular frictional area 12 is illustrated.

[0019] After the thermal spray-coating has been carried out, the mask 5 is taken off the folding roll 1, to which the four-cornered frictional areas 3 and rectangular frictional areas 12 are then applied. Between them there are deeper areas, which are formed by application-free regions which originate from the regions covered by the mask 5. The folding roll 2 produced in the manner described is advantageously used in third longitudinal folding apparatuses, as shown in Fig. 4. In this third longitudinal folding apparatus 13, two folding rolls 1 operate together. A sheet 15 to be folded is inserted into their inlet gap by means of a folding blade 14. The tape lines 11 run in the grooves 10 in the folding rolls 1. These are driven by friction on the frictional areas 12. The folding roll 1 can also be used on buckle folding apparatuses, the tape lines 11 and grooves 10 being superfluous.

[0020] The folding rolls 1 used in the third longitudinal folding apparatus 13, as shown in Fig. 4, can also be provided with the frictional areas 3 over only one circumferential region. A mask 5 which is used in this case and which has cutouts 8 accordingly extending over only part of the width B can be fitted to the folding roll 1 with its ends 6, 7 overlapping.

[0021] Fig. 3 shows a further variant of a folding roll 16, in which a frictional layer 2 is formed by a strip 18 running around spirally on the circumference 17 of the folding roll 16. For the production of this strip 18, a mask 19 is wound spirally onto the circumferential surface of the folding roll 16 to be coated, leaving the strip region to be coated free. In Figure 3, the winding operation is shown schematically on the folding roll 16, which is shown in part. The ends of the mask 19 are fixed to the circumference 17 by means of a clip or in another way, for example by means of spot-welding. As described in the previous exemplary embodiment, the frictional layer is then applied to the folding roll 16 together with the mask 19 by means of thermal spray-coating, if appropriate following previous sand-blasting. Then, the mask 17 is removed, whereupon the frictional layer is constituted in the form of the strip 18 running around spirally. The strip 18 is shown schematically on a subregion of the circumference 17 of the folding roll 16. For the mask 19, use is made of a sheet-metal strip 1 mm thick, for example. The frictional layer, that is to say the strip 18, is advantageously again implemented with a thickness of about 0.3 mm. The flame-spraying is carried out as described in the previous exemplary embodiment, for which reason repeated explanations are superfluous. The strip 18 has, for example, a width b of about 10 mm. It is also possible to apply to the folding roll 16 a strip which consists of a sequence of individual rectangular areas. In this case, the mask contains corresponding windows 21, which are also shown by dash-dotted lines as a design variant. In this case, too, the strip 19 is wound on without an interspace b (therefore $b = 0$).

[0022] The folding roll 16 is advantageously used on a folding former 22, as shown in Fig. 5. Here, two folding rolls 16 operate together. A web 23 folded longitudinally by the folding former 22 is fed into their inlet gap.

[0023] Thus, while there have shown and described and pointed out fundamental novel features of the invention as applied to a preferred embodiment thereof, it will be understood that various omissions and substitutions and changes in the form and details of the devices illustrated, and in their operation, may be made by those skilled in the art without departing from the spirit of the invention. For example, it is expressly intended that all combinations of those elements and/or method steps which perform substantially the same function in substantially the same way to achieve the same results are within the scope of the invention. Moreover, it should be recognized that structures and/or elements and/or method steps shown and/or described in connection with any disclosed form or embodiment of the invention may be incorporated in any other disclosed or described or suggested form or embodiment as a general matter of design choice. It is the intention, therefore, to be limited only as indicated by the scope of the claims appended hereto.